NPS-FM-04-023

EXCERPT FROM THE

# PROCEEDINGS

OF THE

# FIRST ANNUAL ACQUISITION RESEARCH SYMPOSIUM

## TOTAL OWNERSHIP COST: AN EXERCISE IN DISCIPLINE

**Published: 30 September 2004**

**by**

**Michael W. Boudreau and Brad R. Naegle**

**2nd Annual Acquisition Research Symposium of the Naval Postgraduate School:**

**Charting a Course for Change: Acquisition Theory and Practice for a Transforming Defense**

**May 13, 2004**



Prepared for: Naval Postgraduate School, Monterey, California 93943

ACQUISITION RESEARCH PROGRAM
GRADUATE SCHOOL OF BUSINESS & PUBLIC POLICY
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# Report Documentation Page

*Form Approved*
*OMB No. 0704-0188*



| 1. REPORT DATE | 2. REPORT TYPE | 3. DATES COVERED |
|---|---|---|
| **30 SEP 2004** | | **00-00-2004 to 00-00-2004** |

| 4. TITLE AND SUBTITLE | 5a. CONTRACT NUMBER |
|---|---|
| **Total Ownership Cost: An Exercise in Discipline** | 5b. GRANT NUMBER |
| | 5c. PROGRAM ELEMENT NUMBER |
| 6. AUTHOR(S) | 5d. PROJECT NUMBER |
| | 5e. TASK NUMBER |
| | 5f. WORK UNIT NUMBER |
| 7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **Naval Postgraduate School,Graduate School of Business and Public Policy,555 Dyer Road, Room 332,Monterey,CA,93943** | 8. PERFORMING ORGANIZATION REPORT NUMBER |
| 9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES) | 10. SPONSOR/MONITOR'S ACRONYM(S) |
| | 11. SPONSOR/MONITOR'S REPORT NUMBER(S) |

12. DISTRIBUTION/AVAILABILITY STATEMENT
**Approved for public release; distribution unlimited**

13. SUPPLEMENTARY NOTES
**1st Annual Acquisition Research Symposium: Charting a Course for Change: Acquisition Theory and Practice for a Transforming Defense, 13 May 2004 in Monterey, CA**

14. ABSTRACT
**see report**

15. SUBJECT TERMS

| 16. SECURITY CLASSIFICATION OF: | | | 17. LIMITATION OF ABSTRACT | 18. NUMBER OF PAGES | 19a. NAME OF RESPONSIBLE PERSON |
|---|---|---|---|---|---|
| a. REPORT **unclassified** | b. ABSTRACT **unclassified** | c. THIS PAGE **unclassified** | **Same as Report (SAR)** | **25** | |

The research presented at the symposium was supported by the Acquisition Chair of the Graduate School of Business & Public Policy at the Naval Postgraduate School.

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The following article is taken as an excerpt from the proceedings of the annual Acquisition Research Program. This annual event showcases the research projects funded through the Acquisition Research Program at the Graduate School of Business and Public Policy at the Naval Postgraduate School. Featuring keynote speakers, plenary panels, multiple panel sessions, a student research poster show and social events, the Annual Acquisition Research Symposium offers a candid environment where high-ranking Department of Defense (DoD) officials, industry officials, accomplished faculty and military students are encouraged to collaborate on finding applicable solutions to the challenges facing acquisition policies and processes within the DoD today. By jointly and publicly questioning the norms of industry and academia, the resulting research benefits from myriad perspectives and collaborations which can identify better solutions and practices in acquisition, contract, financial, logistics and program management.

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# Total Ownership Cost: An Exercise in Discipline

**Presenter: Michael W. Boudreau,** Senior Lecturer, Graduate School of Business & Public Policy, Naval Postgraduate School

**Presenter: Brad Naegle,** Lecturer, Graduate School of Business & Public Policy, Naval Postgraduate School

## Introduction

## Presenter: Michael W. Boudreau

As a first step, we felt it was important to gather research and data relating to total ownership cost initiative, without bias and complicating the process. This, in itself, is quite a task, as there had been quite a bit of work done in the area over the last two years in all services and numerous DoD programs.

This presentation is designed to provide some insight and perspective into what we've drawn upon from the work done.

## Presenter: Brad Naegle


Figure 1. Photo Courtesy of DAU

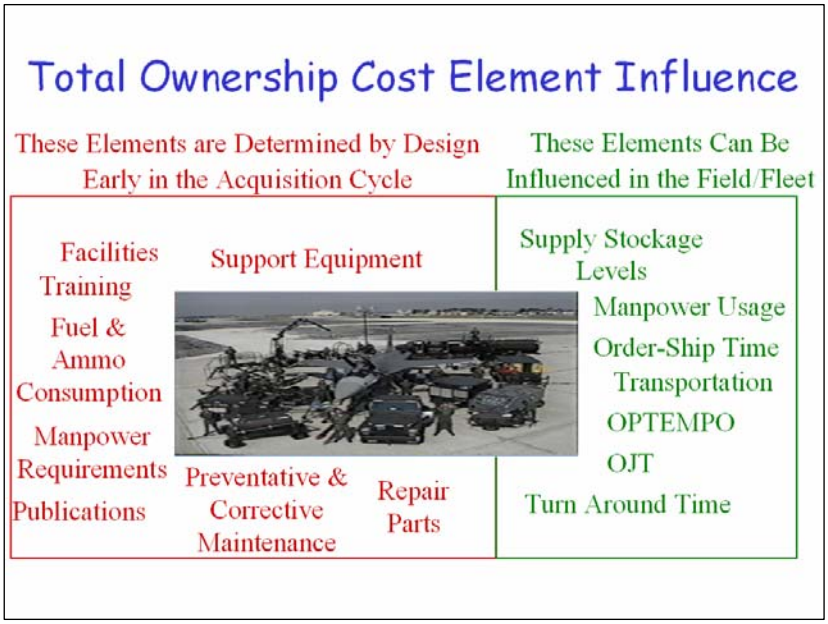
Here you have an F-16. When people think about an F-16 this is what they see. They say 'there's the bird, I can fly that' or that's an F-16 you can fly today.

If you want to fly one tomorrow, it looks more like this.


Figure 2. Photo Courtesy of DAU

Of course this is tests, measurement, diagnostic equipment, all the support equipment, all folks at earned Dalton embedded within that are the software processes and go along with it, all the training and education that as go out with the crew supporters of the system. And that is truly an F-16 you can fly for longer than a day. So when we think about things logistically total ownership cost wise. That's the system, and that's of course the cost driver to her trying to attack today.


These cost elements here make up the logistics footprint. This is by no means an exhaustive list. But there are a lot of elements around that that you can see that really impact and add to the cost of ownership for the system. That is logistics footprint.

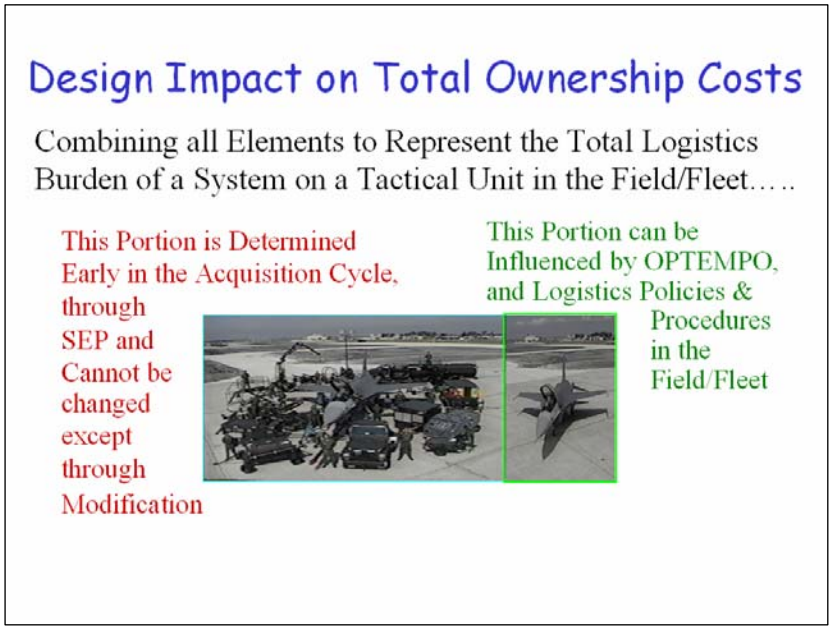


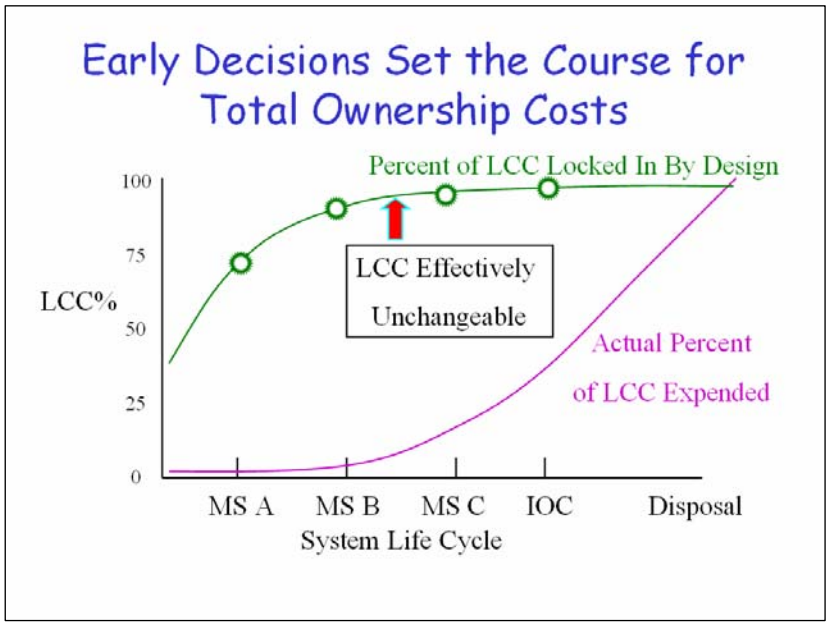

If you divide that out and that green line you see come down into the picture was put there on purpose, those items that show up on the right side in green are typically those that you can influence after deployment of the system in the field or the fleet. You can choose to do some of those things or not do some of those things or just how you do those things.

That big chunk on the left that's in the dark red, are those things that are actually 1) determined during the acquisition process, 2) during the design and acquisition process of the

system and 3) without a really significant reengineering, are hard to change. Of course, that's about the percentage of the cost that's involved in that and where that cost comes from.

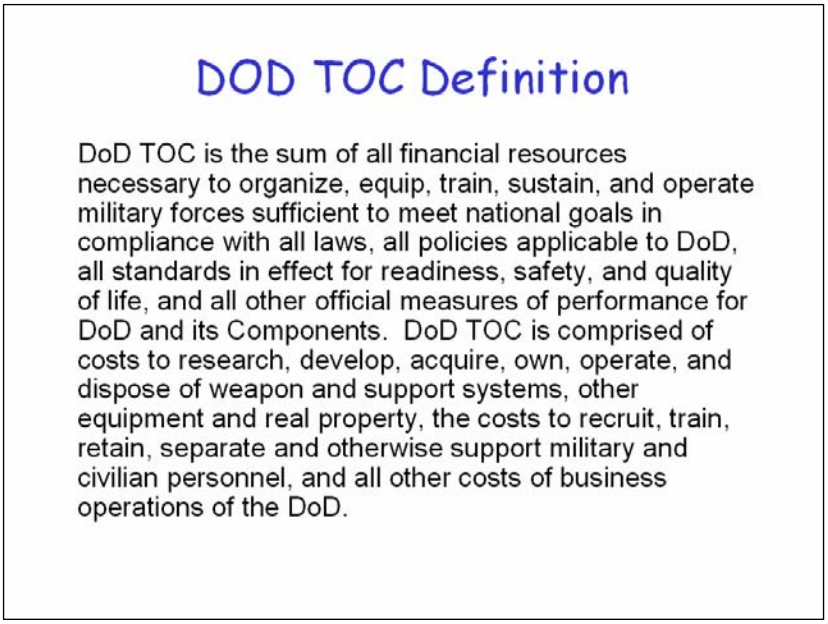
The green are the things that can be influenced in the field and the fleet and the rest of that. If we're asking people in the field or the fleet to reduce their costs by 10%, their taking 10% of that green block off of there and may not even be noticeable to the actual cost of the system. Where we need to attack this is clearly on the left hand side of that chart.



So, how do we spend money on the system? If you look at the purple line at the bottom, that is how we expend the dollars when we procure and support a system over it's lifecycle from Milestone A, or before Milestone A, through disposal. That's important. Everyone pays a lot of attention to that purple line and how we expend those dollars. The green line on top represents the percent of the lifecycle costs that are locked in at various stages. You can see, by the time you get past Milestone B you have effectively locked in the lifecycle and the cost of that system. It's going to be very difficult to change without significant engineering beyond that point. We haven't spent a great deal of the money for the total ownership of the cost of the system at that time but we have determined it.

## Presenter: Michael W. Boudreau



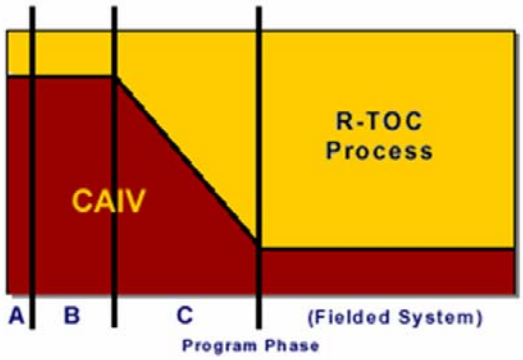

When we talk about total ownership costs we're talking about a lot of different aspects. We're talking about the personnel, the institutional costs, the system itself, the operating and support; that includes maintenance man hours, uniformed military members and civilian maintenance man hours, the repair parts, all the test equipment. It's easier to get an understanding of TOC in the charts just shown to you in the last few minutes. You could see in a pictorial way what was included. At least some of these items are well beyond the ability of program managers to deal with by themselves. The guidance that came out in 1998 in respect to system TOC suggested the program managers should go and get all the help they could muster within DoD because TOC reduction was a very big job and certainly had to be done by lots and lots of different people simultaneously.

## System TOC Definition

Defense Systems TOC is defined as Life Cycle Cost (LCC). LCC (per DoD 5000.4M) includes not only acquisition program direct costs, but also the indirect costs attributable to the acquisition program (i.e., costs that would not occur if the program did not exist). For example, indirect costs would include the infrastructure that plans, manages, and executes a program over its full life and common support items and systems. The responsibility of program managers in support of reducing DoD TOC is the continuous reduction of LCC for their systems.

Those are the definitions that go with total ownership cost: One from an institution perspective, and the other from perspective of a war-fighting system itself. You can see those costs are pretty inclusive. If we were to put them on an acquisition timeline, it would cover all the RDT&E, the Research, Development, Test, and Evaluation activities and would stretch out all the way through disposal.

## CAIV and R-TOC




The two buzz-words that I think have predominated in discussion related to TOC really show up nicely on this milestone and phase chart: The first being cost as an independent

[1] Kaye, Michael A., Mark S. Sobota, David R. Graham, and Allen L. Gotwald. "Cost As An Independent Variable: Principles and Implementation." *Acquisition Review Quarterly*. Fall 2000.

variable (CAIV). That is, in my humble description, figuring out how much money that you've got to devote to a war-fighting system and using that as one of the hard and fast "rocks" that constrain how you develop, and what you are able to develop. Finally, when the system is fielded, figuring out ways, throughout the life of the system to reduce ownership costs in areas that maybe you didn't understand completely as you would in ideal circumstances during the development itself. Even with beautifully developed systems, there are always opportunities for taking corrective action afterward -- this notion of continuous process improvement that reflects in RTOC, Reduction in Total Ownership Cost. Finding those ways by looking at cost drivers, particularly as the system is put into service, either in the field or in the fleet.

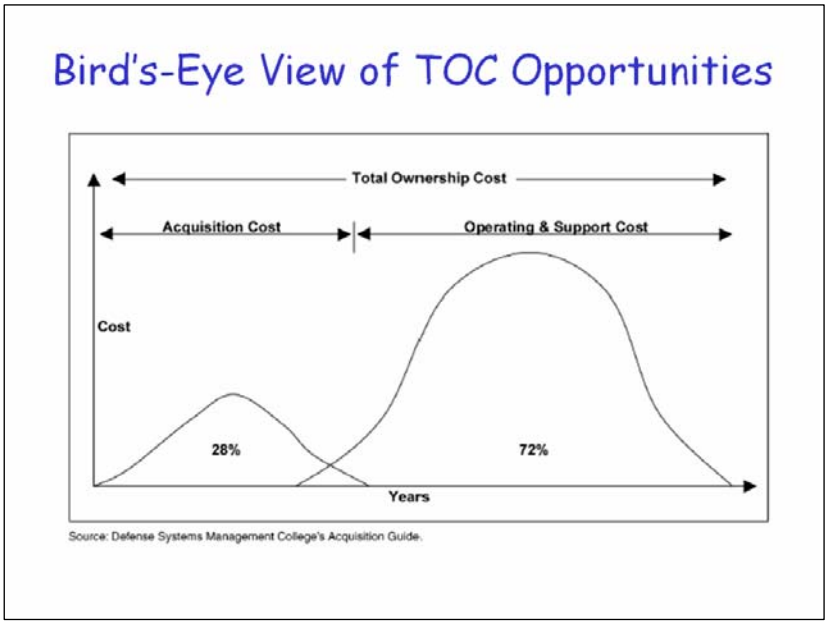



Figure 4. Nominal Life-Cycle Cost of Typical DoD Acquisition Program with a Thirty-Year Service Life [2]

Another way of looking at TOC is on a percentage basis by when it happens. It is generally considered about a third, 28% if you want to be more precise looking across a number of programs, 28% of the TOC is in the acquisition phase, RDT&E and procurement. On the average, over numerous systems 72% is spent in operating and support costs. Which part is it that the PM is most attentive to? It is obvious, those things that the PM can touch closest-in. That routinely is RDT&E and procurement. When we say that the PM has to be a total life cycle cost system manager then we're really saying 'Mr. PM, we think that you need to focus a huge amount of your attention *also* on those operating and support costs and we are holding you responsible to do that.' That sounds, from my perspective, very logical, but in the doing is pretty tough. The reason being, that there's nothing that really connects in an easily definable, clear way, the amount of monies that are going to be spent on those systems that the program manager is responsible for. There is no way to connect him to those O&S costs. So you have to come up with artificial mechanisms: actually putting down operating and support costs in the PM's acquisition strategy and his acquisition baseline. But then how do you measure it? It's pretty hard to measure because, of course, those costs may not be incurred until 5 to 15 years in the future. How do you know whether a PM is doing a good job in that respect, or not? There

[2] Ibid.

may be ways of getting at TOC metrics, but it's not as clear as going out and measuring what's left in the bank account. It's much more complex.

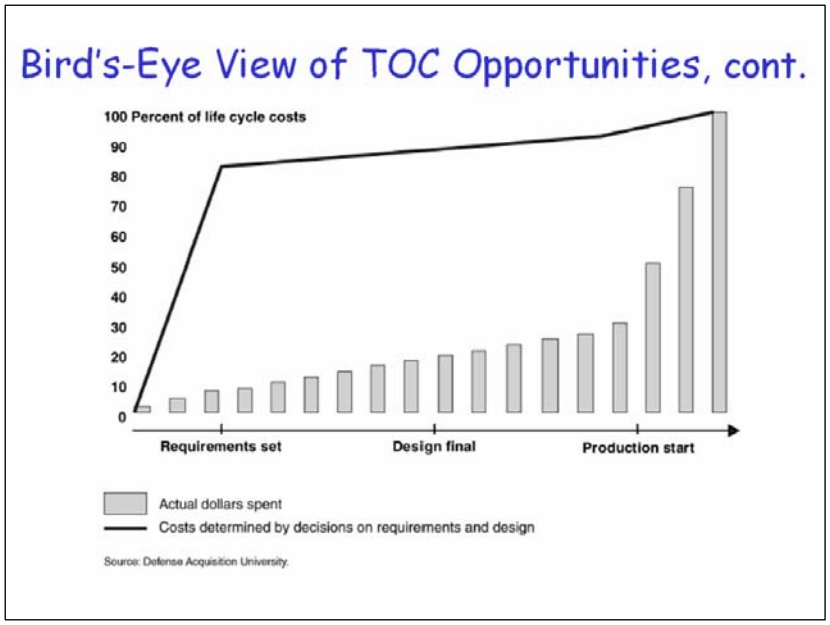



Figure 5. Design Decisions vs. Expenditure of Funds[3]

This chart is very similar to the one Brad just showed you. The thing that I'd like to note from the chart is that this is ascribed to the Defense Acquisition University. The interesting thing about this chart is that I pulled it out of a GAO report. What should you get from all that? To me, we should get that we've understood for a long time this mantra about 'up front and early': Needing to pay close attention to those things that are most important and dear to us at the very beginning of a developmental process. If we wait too long we will be unable to affect, to the extent we'd like to, those attributes; be they cost or performance attributes, either one. Just to reiterate, because our milestones and phases don't show up on this chart. We think that we get perilously close to the 90% locked-in position by the time we get to Milestone B. For those of you who don't work in acquisition every day, what does that mean? Milestone B is where the program manager gets assigned. Up until that time it's probably been a study group made up of many stakeholders under the direction of the user. At Milestone B when there's a formal decision to go ahead with this program, then a program manager is assigned probably just before that but not long before that. So when we talk about upfront and early from the

[3] U.S. General Accounting Office. "Best Practices: Setting Requirements Differently Could Reduce Weapon Systems' Total Ownership Costs." Report to the Subcommittee on Readiness and Management Support, Committee on Armed Services, U.S. Senate. GAO-03-57. February 2003.

perspective of influencing TOC we're talking while the concept is still in the hands of the user and is not actually being developed by the acquisition community.

## Presenter: Brad Naegle

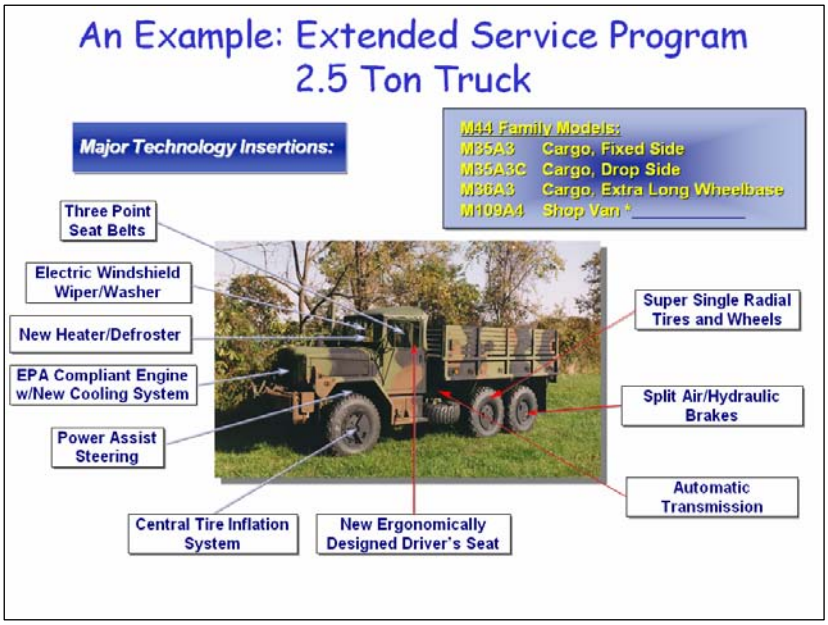
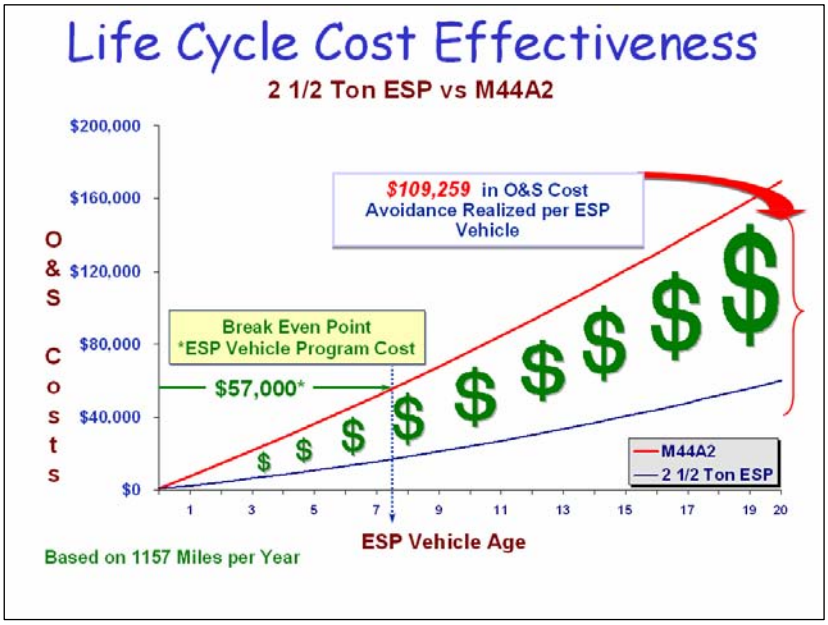



Figure 6. Photo courtesy of DAU

We tried to find some examples of this. This happens to be the program that I managed: The Extended Service Program. It was a service life extension program of the 2.5-ton fleet of trucks. This shows the truck and some of the neat things we did to it when we remanufactured it. The remanufacturing process tore the truck down to components and built it up like a new system. The idea was to start with an old 2.5-ton truck and end with a 2.5-ton truck. What we were trying to attack was the total ownership cost, the operations and support costs of this truck. But we did add some enhancements as we went through the thing. Some of my students who see this chart are kind of amazed. We said we put in a new heating and defrosting system that did two really unique things for that truck series: Heated and defrosted. That doesn't sound like a great thing until you drove the old truck, then you realized it was a really great thing. We did enhance it as we went through this.

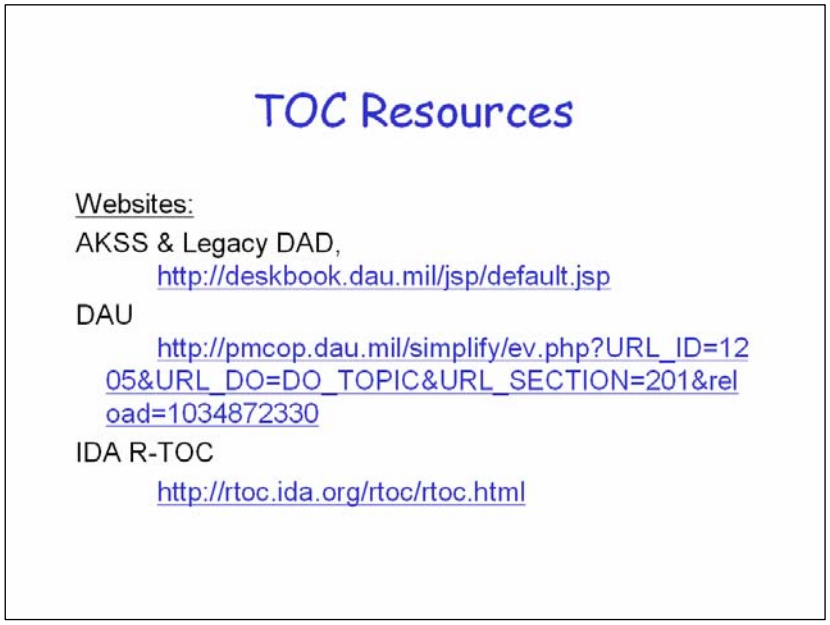
The whole idea was to reduce the total ownership cost. This is kind of what it looked like over a short period of time.




First of all, the entire weapons system cost of the truck was about $57,000. That included everything up until that point. The contract price was much less, around $44,000 a truck, but the fully burdened cost was $57,000 per truck. The blue line on the bottom is the total ownership cost of the new 2.5-ton extended service program. This data was extracted from 100,000 miles of testing. It was not projected but a projection of something we had empirical data for. The red line at the top was the cost of supporting an existing 2.5 ton truck in the system and reflects that they were very old and very costly. They went about 1,000 miles between hardware mission failures. They were very costly to support.

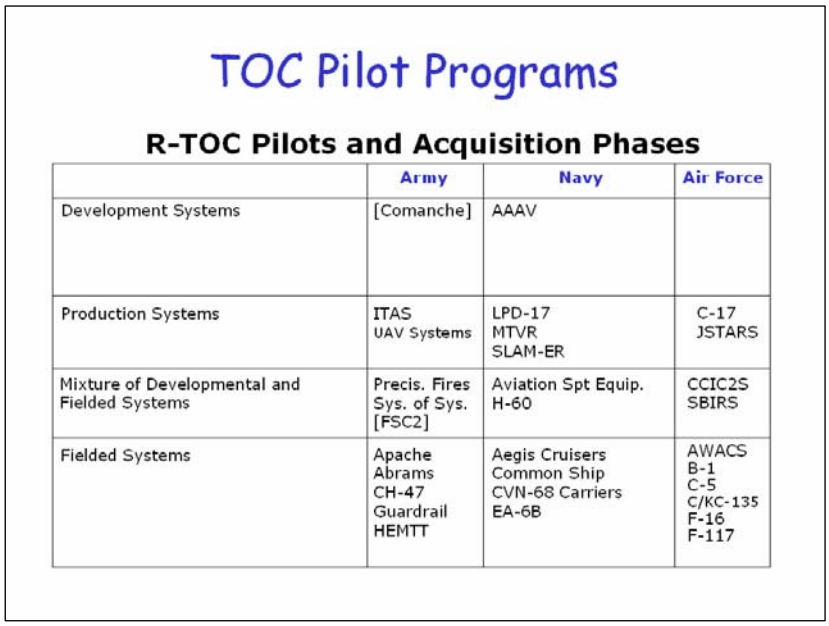
We were bringing on a new series of truck, that Mike Boudreau was in charge of at the time, the family of medium tactical vehicles, but we couldn't bring them on fast enough because of the costs that are involved. So, we needed to do something to the fleet to keep the total ownership costs down.

As I was trying to sell this program as the program manager, I looked at the difference between the red line and the blue line equaled the total cost of getting a new ESP truck. That happened at just between seven and eight years. The truck was basically paid for in less than eight years of service as far as the differential in cost between the old and the new truck. The truck was re-baselined to 0 miles and it had a twenty year life span beyond that. So, if you go all the way out to the 20-year mark, the savings, per truck, ended up being $109,258. Which was a magic number because it was about the cost of a brand new FMTV replacement 2.5-ton truck. Not only did I pay for my own efforts within eight years but if you kept one it's entire life, you saved enough money to buy it's replacement. Great story but it didn't go over particularly well. People didn't like the idea of remanufactured trucks. Nonetheless, that was the concept behind it. It was quite effective and turned out to be about what you see on that chart.




## Presenter: Mike Boudreau

One thing worth mentioning; there is a wonderful database out in our acquisition community related to TOC. What we've done here is put down some of the sites where you can get some good information that shows you how robust the effort has been over the last few years. If you're not familiar with some of these acronyms; AKSS is the Acquisition Knowledge Sharing System which is a DoD/OSD website that replaces what was on CD ROM. It was formerly called the Defense Acquisition Desk Book. In fact you can get the web version of that on websites today even though it has become obsolete. DAU is the Defense Acquisition University. They have quite a body of material that has put together on TOC. IDA, the Institute for Defense Analysis, has an R-TOC website that includes 30 systems that cover all the services.



## TOC Pilot Programs

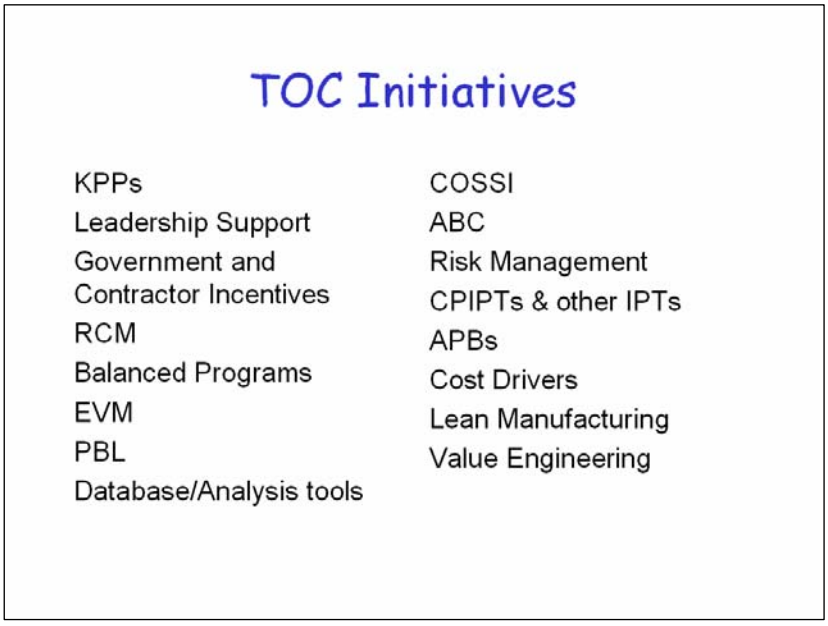
### R-TOC Pilots and Acquisition Phases

| | Army | Navy | Air Force |
|---|---|---|---|
| Development Systems | [Comanche] | AAAV | |
| Production Systems | ITAS<br>UAV Systems | LPD-17<br>MTVR<br>SLAM-ER | C-17<br>JSTARS |
| Mixture of Developmental and Fielded Systems | Precis. Fires Sys. of Sys. [FSC2] | Aviation Spt Equip.<br>H-60 | CCIC2S<br>SBIRS |
| Fielded Systems | Apache<br>Abrams<br>CH-47<br>Guardrail<br>HEMTT | Aegis Cruisers<br>Common Ship<br>CVN-68 Carriers<br>EA-6B | AWACS<br>B-1<br>C-5<br>C/KC-135<br>F-16<br>F-117 |

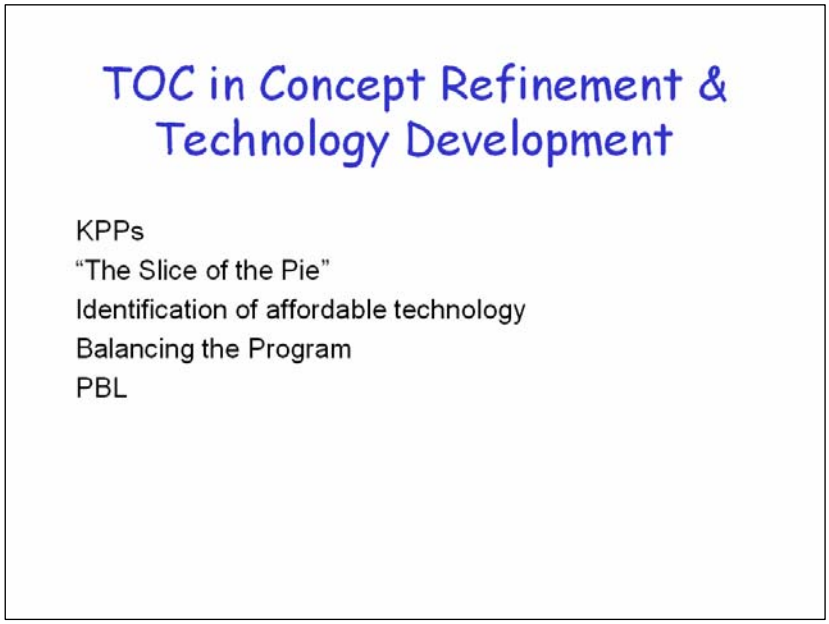
There it is. By way of apology one of the things that's happened in the intervening time since we did this research was that Comanche has fallen off this list. Not because they did anything really wrong in the way that they wanted to proceed with TOC but maybe the program was simply too costly when combined with other warfighter needs. Also there's a Fire Support Command and Control Army System that shows up under the fielded system that is a follow-on to AFATIDS for those of you who are followers of army command and control systems. That's also fallen off the list recently.

At any rate, as you can see here is that in each of the services there were 10 TOC pilot systems, pilot programs that were used to put together and test R-TOC ideas. There are a lot of them here that I'm sure you are familiar with besides the ones that I've mentioned.

AAAV is the Marine Corps Advanced Amphibious Assault Vehicle. It's now called EFV the Expeditionary Fighting Vehicle. The name has changed but the system is the same. MTVR has been discussed earlier today that is the Marine Corp medium tactical vehicle replacement. H60 is a helicopter program. EA-6B is the Prowler an electronic aircraft. CVN68 is the aircraft carrier that has been used as a test bed for some of these R-TOC ideas. AWACS you're familiar with and JSTARS. I suspect many of you are familiar with. F-117 is the stealth fighter. F-16 is ubiquitous, everybody knows about it. So, you can see there are quite a selection of different programs that have provided test beds, some of which have already begun to show dividends in terms of R-TOC. In some of these systems, it will be years before we see the dividends of the R-TOC work that's been done.

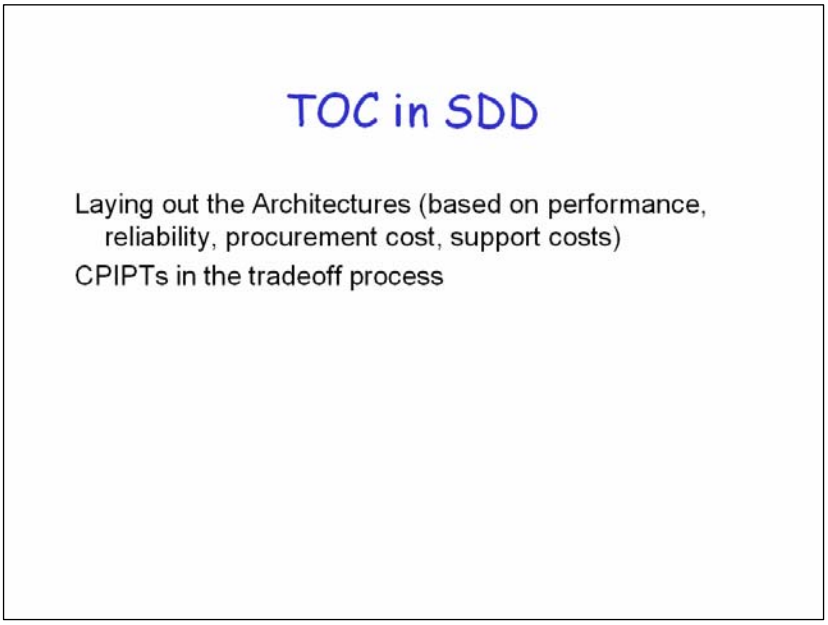



There are lots of different TOC initiatives. KPPs are Key Performance Parameters. Those are parameters that are identified by users as elements that are most important to a system that's being considered for acquisition. KPPs doctrinally now show up in what used to be called the ORD, Operational Requirement Document but is now called the CDD, the Capability Development Document and its follow on user document that supports production. At any rate KPPs are those areas that are so important to the user that if they cannot be achieved that throws into question whether or not we should go on with this development and acquisition of the system.



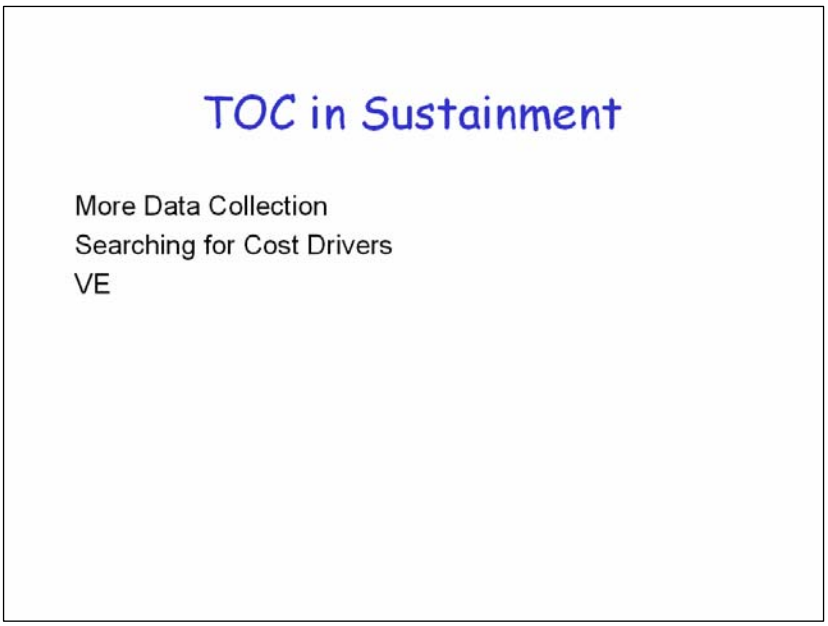

You would think if cost is really important to the DoD that at least on some programs you would see a TOC metric as one of those KPPs. I submit to you that you have to look a long way to find that because that is not what is most attractive to military users. Being in the military once upon a time, I can relate. We are more interested in the "pointy end of the stick." But,

what good is it to have the world's greatest warfighting system if we can't afford to acquire it, or later on, to maintain it or sustain it? We think the KPPs are an area where we ought to start defining the number of dollars we are going to spend on a program and make cost so important that if we can't stay within TOC constraints, maybe we don't need the warfighting system in that form.




Reliability Centered Maintenance is important. RCM has been around for a very long time. That's another thing that the GAO has played back to us of things that we've known for years and years, decades for heavens sake. Lots of those TOC pilot programs are working on going back to review the basics of reliability centered maintenance, which is a very worthwhile endeavor.

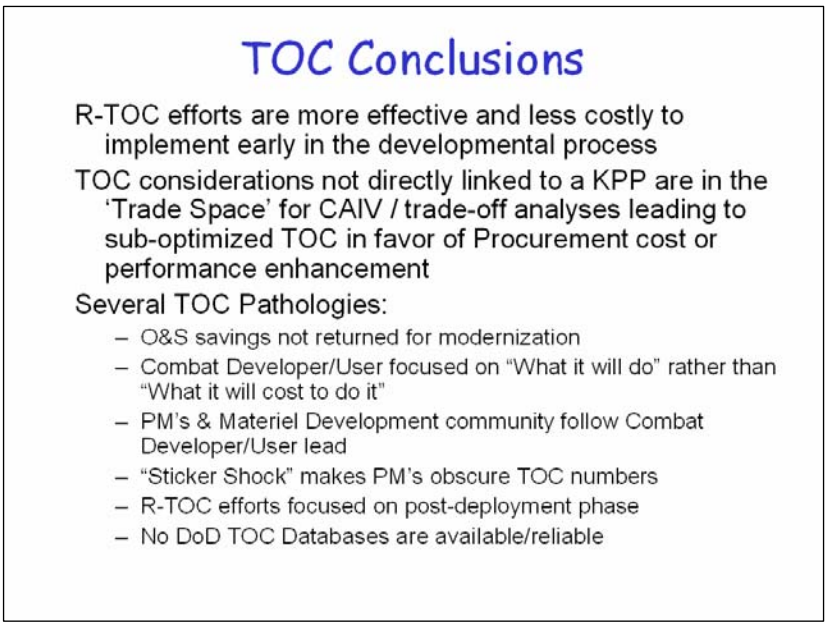
You will hear a lot more about PBL, Performance Based Logistics throughout the day. That is very closely related to the control of TOC. PBL has to be a constituent consideration for what that sustainment, in fact, is going to cost.




Cost drivers, looking at those things that are most expensive in fielded systems, is one of the very fruitful ways of getting at R-TOC for legacy systems. Through modification of systems, maybe we can reduce the cost of ownership.

Value engineering is another program that has been around forever. Value engineering kicks in after production starts. Often we spend many more dollars than is necessary in early production because of things that we didn't understand completely, but that we begin to understand more fully as time goes on. The way that we can get at needed changes and address the associated production and sustainment costs is through value engineering change proposals.

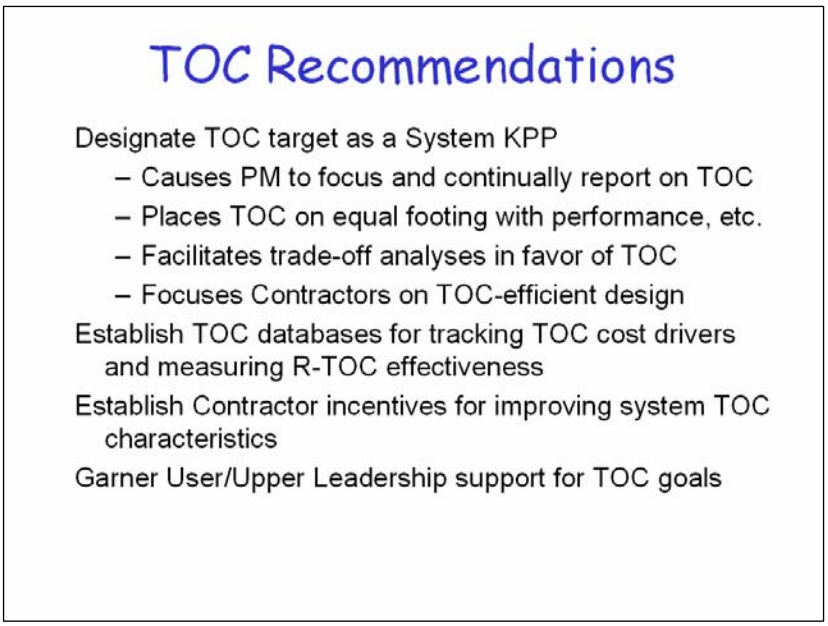
Those are just a few of the TOC initiatives. Frankly, we haven't, in our study come up with any of those ideas. They've all been out there being used by one program or another within the community, but maybe not used to the extent that they should.




By way of conclusion, we think that the earlier you begin considerations of Total Ownership Cost in a program acquisition, the more effective you are likely to be. We also think as I've mentioned before, that focusing on ownership cost as a Key Performance Parameter (KPP) makes it so important that it cannot be traded away. We also think there are a lot of things counterbalancing TOC. Some of them are pretty simple. We tell people to do one thing but we incentivize them to do another. What happens to operating and support savings? Can the community that makes the savings, use the savings to plow back in and get other beneficial results? Oftentimes not! Those savings are taken away and used elsewhere, probably for very useful things, but it's a disincentive for program managers and users. We think that combat developers, the user community, is not as focused on how much war-fighting system costs, as maybe they should be. They are interested in warfighting capability, not how that capability is going to be sustained. We think that program managers and material developers typically will follow the lead of the user community. If the user community identifies the importance of ownership cost and makes sure that TOC translates into the acquisition program baseline, the program managers and their communities will follow that lead and manage it to the best of their ability. We also think R-TOC should be a continued focus in legacy systems and in the post-deployment phase because there are always ways of taking cost out of systems even though it may take a little bit of up-front money in order to get yourself to that point.

One of the things that we think is an important pathology that in fact the TOC databases have not really matured yet.

In all the services there are problems with databases. When you think about that, if you don't have a good cost and performance database that describes your legacy systems, then do you have all the tools that you need in order to progress with the follow-on systems? We think the answer is that we've not come up with databases that are as complete and flexible as we need. It's been a problem in all the services and all the services have devoted R-TOC focus in trying to develop better databases. Oftentimes, those databases exist but they exist in a lot of different places in ways that are somewhere between difficult and impossible to patch together so as to get meaningful collective data from them.




By way of recommendations from the research we've done:

- It's clear that we think the TOC ought to be described in Key Performance Parameters (KPP). That will cause program managers and their staffs to continue to pay attention to the total life cycle cost of the system.
- More work needs to be done to continue to enhance our databases such that they will be good tools for us to do more focused work in reducing TOC.
- We think that we have contractual mechanisms, but we need to refocus those toward keeping the contractor involved in R-TOC. Once again, there have been some initiatives that have been done in the pilot programs that look to have great promise in that respect.
- Leadership support is necessary in order to make TOC a focus within each of the services. Certainly without that leadership support, will those key questions be asked at our different meetings, such as milestone decision meetings? Without the hard TOC questions being asked at the leadership level, the workforce won't focus on the issues of TOC, because they see that it is not what the boss considers to be important.

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- Spiral Development
- BCA: Contractor vs. Organic Growth

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- USAF IT Commodity Council
- Contractors in 21st Century Combat Zone
- Joint Contingency Contracting
- Navy Contract Writing Guide
- Commodity Sourcing Strategies
- Past Performance in Source Selection
- USMC Contingency Contracting
- Transforming DoD Contract Closeout
- Model for Optimizing Contingency Contracting Planning and Execution

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- PPPs and Government Financing
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- Capital Budgeting for DoD
- Financing DoD Budget via PPPs
- ROI of Information Warfare Systems
- Acquisitions via leasing: MPS case
- Special Termination Liability in MDAPs

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- R-TOC Aegis Microwave Power Tubes

- Privatization-NOSL/NAWCI
- Army LOG MOD
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- ASDS Product Support Analysis
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